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An Experimental Study on Partial Replacement of Coarse Aggregate with Mangalore Tiles in Self-Compacting Concrete

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***Abstract*: In the world wide the usage of concrete is more in the construction industry which contains maximum volume of aggregates than cement due to this the natural aggregates are depleted day by day. In this project coarse aggregate is replaced with Mangalore tiles in self-compacting concrete ranging from 10%, 20%, 30%, 40%. Mangalore tiles are rejected tiles which are not in ideal size and shape. The various tests are carried out such as compressive strength, flexural strength and spilt tensile strength test at 7 and 28 days for cubes, cylinder and beams. Here the grade of the concrete is M50 and mix design is carried out. Mechanical properties, strength, durability and optimum percentage of crushed Mangalore tiles is observed. Self-compacting concrete is a concrete mix which has a low yield stress, good segregation resistance and moderate viscosity uniform suspension of solid particles during transportation and placement. Mangalore tiles waste is used as coarse aggregate for the present study which can be obtained in the rural areas where the major number of houses is built using these tiles for the roof. The demolition of these generates maximum roof tiles which will be wasted.**

***Keywords*: concrete, compressive strength, flexural strength, Mangalore tiles, mix design, spilt tensile strength test.**

1. Introduction

Mangalore tiles are a type of tile native to the city of Mangalore, India. These are prepared from hard laterite clay, in great demand throughout the country. The tiles were first introduced to India in 1860 by a German missionary. These tiles are Typically considered to be a part of Spanish and Italian architectural styles. Since that time, these tiles become quite famous India.

These red coloured clay tiles, unique in shape and size, are quite famous and are exported to all the corners of world. They are unique and are made and available in different shapes and sizes depending on the users need. Clay tiles are often white, yellow, orange or brown in colour. However, they can be coloured or styled according to one's preference by spraying enamel over the tile once it has been coloured before baking it in the kiln. These tiles are not only eco-friendly but also cheap, durable and costs only one third of that of cement.

They provide excellent ventilation especially during summer and are aesthetically pleasing as well. Some of them are especially made to be used for roofing kitchens (for the smoke to escape) and bathrooms. Over a period of time, these tiles become dark to black from constant exposure to soot and smoke. Clay tiles offer natural insulation, thereby reducing the expense on electricity for heating or cooling as the case may be. Since these clay tiles are moulded under extreme heat, they are resistant to damage or destruction from fire.

Self-compacting concrete (SCC) can be defined as fresh concrete that flows under its own weight and does not require external vibration to undergo compaction. It is used in the construction where it is hard to use vibrators for consolidation of concrete. Filling and passing ability, segregation resistance are the properties of self-compacting concrete. SCC possess superior flow ability in its fresh state that performs self-compaction and material consolidation without segregation issues.

2. Relevance

Light weight aggregate has great advantages when used in concrete such as low density and thermal insulation property. Intensely heated clay falls under this category and is strong enough to be used for structural purposes. Overheated Mangalore tiles are used in this experiment as they are entirely made up of clay and are not used in construction due to its deteriorated aesthetics.

Till now very limited research available on utilization of Mangalore tiles as partial replacement of coarse aggregate in concrete. The type of concrete will be assessed is not simply ordinary concrete but self-compacting concrete. Main aim of research being making the things economical and durable this study fits into that.

3. Literature Review

A. Self-compacting Concrete with GGBS

Nan Su et. al., (2001), proposes a new mix design method for self-compacting concrete (SCC). First, the number of aggregates required is determined, and the paste of binders is then filled into the voids of aggregates to ensure that the

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concrete thus obtained has flowability, self-compacting ability and other desired SCC properties. The number of aggregates, binders and mixing water, as well as type and dosage of superplasticizer (SP) to be used are the major factors influencing the properties of SCC. Slump flow, V-funnel, L-flow, U-box and compressive strength tests were carried out to examine the performance of SCC, and the results indicate that the proposed method could produce successfully SCC of high quality. Compared to the method developed by the Japanese Ready-Mixed Concrete Association (JRMCA), this method is simpler, easier for implementation and less time-consuming, requires a smaller amount of binders and saves cost.

P. Dinakar et. al., (2013), presented a new mix design methodology for the design of self- compacting GGBS concretes based on the efficiency concept. The methodology has already been successfully verified through a proper experimental investigation and the self-compacting slag concretes were evaluated for their self compactability and strength characteristics. The results indicate that the proposed method can be capable of producing high quality SCC. SCCs with strengths ranging from 30 to 100 MPa can be easily designed using GGBS. High volumes of GGBS up to 80% could be used in developing SCCs.

Abdallah et. al., (2019), investigated the fresh and hardened properties of SCC produced by GGBS and MK as partial cement replacement. Cement was replaced with MK at a constant level of 10% while GGBS is substituted cement at various levels of 15%, 20%, 25% and 30% as a ternary blending powder. Results obtained indicates that the inclusion of MK reduced the workability, oppose finding for GGBS exhibited improvement in the workability. For the hardened properties at an early age, mix which contained MK showed improvement in the strength characteristics, whilst at later age the mix with a combination of MK and GGBS exhibited better performance. From this study, it can be concluded that the optimum replacement level of cement to produce good quality of SCC is 10% and 25% for MK and GGBS, respectively.

B. Replacement of Coarse Aggregate with Various Tile Waste

D. Tavakoli et. al., (2012), investigated the possibility of using waste ceramic tile in concrete. First, the characteristics of ceramic aggregate are measured and then being grind they are used in concrete as the substitute for coarse aggregates with 0 to 40 percent of substitution and also for sand with 0 to 100 percent of substation. Besides, all other parameters are constant, the slump value, compressive strength, water absorption, and the unit weight of concrete for the samples were calculated. The findings revealed that generally using waste ceramic tile led to enhancing the properties of concrete.

Sudarshan D. Kore and A. K. Vyas (2016), study was utilization of marble waste as a replacement for conventional natural coarse aggregate in concrete. Experimental investigations were carried out to examine the feasibility of use of marble waste as a coarse aggregate in concrete. Conventional natural coarse aggregate was replaced by marble aggregate in different percentages 0–100% by weight. The concrete formulations were prepared with a constant water–cement ratio 0.60. It was observed that workability of concrete mixes containing marble aggregate was 14% more than that of control concrete. The average compressive strength of all the concrete mixes containing marble aggregate increased by 40% and 18% at 7 and 28 days, respectively. Compressive strength of the concrete shows upward trend till 80% marble used as coarse aggregate in concrete.

Samia Tariq (2017), focused on the findings of concrete produced with glass and ceramic tile wastes to explore their influence on fresh and hardened properties of concrete. Total number of 63 cubes were prepared and tested. Compressive strengths were calculated at 7, 28 and 63 days of standard curing at varying waste contents as coarse aggregates. It was found that from the results that compressive strength of concrete containing glass waste decreased and containing ceramic tile wastes increased with curing time. The addition of 10% ceramic waste replaced by coarse aggregates demonstrated approximately similar performance than that of control concrete. The compressive strength increased with the addition of ceramic content in concrete. This concludes that waste ceramic tiles can be utilized as a partial replacement to coarse aggregates in concrete.

Aswathy et al., (2018), in their replaced the crushed natural stone aggregate by clay tile aggregate in 25, 50, 75 and 100% by volume. The control mix containing natural aggregate and mix with clay tile aggregates partially or fully replaced prepared in the laboratory and tested. The compressive strength, modulus of elasticity, modulus of rupture, tensile strength was determined. The test results indicated that replacement of natural aggregate by 25% by volume with the broken clay tile can be recommended. Thereafter, the reduction in the strength is found to be significant.

C. Replacement of Coarse Aggregate with Various Marble Waste

Arya Elizabeth et. al., (2016), made Geo-polymer concrete with partial replacement of coarse aggregate using Mangalore tile pieces. The compressive strength of proposed concrete was found to increase by about 50% when 25% replacement of coarse aggregate with Mangalore tile was done. Similarly, the flexural strength and split tensile strength of concrete increased by 13% and 7% respectively.

P. Kiran Bhat et. al., (2018), utilized overheated Mangalore tiles are used in this experiment as they are entirely made up of clay and are not used in construction due to its deteriorated aesthetics. Experimental study on the compressive strength of M25 grade concrete with the partial replacement of coarse aggregate by using highly heated Mangalore tiles. The sample are casted with 0%, 10%, 20%, 30%,35%,40% replacement of coarse aggregate and tested for 7- and 28- days strength with proper curing. The results show that 35% replacement level of coarse aggregate attained workable concrete with satisfactory strength.

4. Proposed Work

A. Objectives

a) To study the mix design for preparation of self-

compacting concrete made with fly ash and GGBS and partial replacement of coarse aggregate by Mangalore tiles.

b) To identify optimum proportion of Fly ash, GGBS and Mangalore tiles in concrete for workability.
c) To identify the optimum mix design which gives maximum strength and required workability.
d) Evaluation of durability of concrete cubes made with Mangalore tiles as partial replacement of coarse aggregate by immersing in water body.
e) Estimating cost of self-compacted concrete made with Mangalore tiles as partial replacement of coarse aggregate.

B. Methodology

To achieve the objectives of this study, the following methodology is adopted,

a) Conducting necessary tests on the materials used in the concrete mixes to determine the physical properties of the materials.
b) Preparation of self-concrete mixes as per the mix design with partial replacement of coarse aggregate with Mangalore tiles.
c) Cubes, cylinders and beams were tested for compressive, split tensile and flexural strength after 7- and 28-days curing period.
d) Important conclusions and recommendations for future work based on the test results.

C. Expected Outcome

It is expected that by end of this research work, a certain conclusion can be drawn regarding optimum percentage of Mangalore tiles in self-compacted concrete.

D. Facilities Required and Available

- The internet access is available in Dr. J. J. Magdum College of Engineering, Jaysingpur.
- Library facilities are available in Dr. J. J. Magdum College of Engineering, Jaysingpur.
- Concrete technology laboratory is available in Dr. J. J. Magdum College of Engineering, Jaysingpur.

5. Conclusion

This paper presented an overview on partial replacement of coarse aggregate with Mangalore tiles in self-compacting concrete.

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